



Coles, A., Liljedahl, P., & Brown, L. (2017). Mathematics teacher learning and doing within professional development. In B. Kaur, W. K. Ho, T. L. T., & B. H. Choy (Eds.), *Proceedings of the 41st Conference of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 257-264).

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MATHEMATICS TEACHER LEARNING AND DOING WITHIN PROFESSIONAL DEVELOPMENT

<u>Alf Coles</u> University of Bristol, UK	Peter Liljedahl Simon Fraser University, Canada	Laurinda Brown University of Bristol, UK
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In this theoretical research report, we aim to consider what is done within professional development activity and how it may or may not approximate to what is done in a classroom. We draw on enactivism to analyse what shifts are needed for a teacher, after engaging in a professional development activity, to make new and effective distinctions in their classroom. Drawing on our own experiences of organising professional development, we consider a range of scenarios, including being offered activities for the classroom and seeing someone else teach your students in your classroom. We conclude that it is a helpful tool in designing activities to consider what is invariant and what varies in mapping what is done within professional development onto what is done in a classroom.

INTRODUCTION

The literature on mathematics teacher learning through professional development has been categorised (Liljedahl, in Brown and Coles, 2010, p.377) into three strands: *content* (of teacher knowledge or belief); *method* (on specific models of professional development); and, *effectiveness* (looking at changes in practice). In this theoretical report, we consider the possibilities for teacher learning across different kinds of professional development activity. In particular, we are interested in what is involved for a teacher in mapping what is done, within a professional development (PD) activity, into their own mathematics classroom practice. We look at a range of PD methods and consider, from a theoretical point of view, what kind of translation or transformation is needed for a PD session be effective. We ask:

1. Who is doing what doing?
2. How does the doing in the professional learning activity approximate the doing in the classroom?
3. What is the role of the doer in the professional learning activity, compared to as a teacher in their own classroom?
4. What is significant about what is invariant and what is the variant?

ENACTIVISM

We draw on enactivism (Reid and Mgombelo, 2015) to help us consider the learning and doing of mathematics teachers, when they are involved in professional development activities, in relation to when they are teaching in their classroom.

Enactivism is a perspective that is informed by systems thinking (Bateson, 1972), phenomenology (Merleau-Ponty, 1962) and a radical view of biology (Maturana and Varela, 1987) that all, in different ways, consider change and relationship as the basis of cognition. From the enactive perspective, the web of relations between components that constitute our being (including any tools we might use) is labelled our 'structure'. Every interaction in the world alters our structure and one of the enactive insights is that humans are 'structure-determined' beings. In other words, when an event occurs which provokes a response, the response we give is not a function of the trigger but a function of our structure. Furthermore, overtime, we become 'structurally coupled' with those people and contexts with which we have recurrent interactions. Each moment of interaction alters, however minimally, my structure and the structure of who and what I am engaging with.

So, in a PD session, each teacher is triggered by the other participants and the leader of the PD and the activities they undergo, changing their structure, making it possible (but not inevitable) for new behaviours to happen when they return to their own classroom. The cultural and the social are embodied in our very beings, in our structure. As a result of the history of our structural coupling, in most situations we make automatic responses, from driving a car to the small prejudices we may catch ourselves projecting onto others who are not like us. Skilled teachers have a vast array of automatic responses in their classroom, which can make it difficult for new behaviours to arise as possibilities unless those automatic responses come to be seen as ineffective for some reason (e.g., a change in school and therefore responses of the pupils, or the teacher becoming dissatisfied with the teacher they are becoming).

Within enactivism 'doing', 'knowing', 'being' are seen as synonymous: 'all doing is knowing all knowing is doing' (Maturana and Varela, 1987, p.27). What it means to know something is to act in an effective manner in a context. There are echoes of behaviourism in this statement but for enactivists there is no denial of an 'inner life', rather a more radical collapsing of the distinction between 'inner' and 'outer'.

In one of Bateson's famous examples (1972), he considered: where does the 'mind' of a blind man with a stick end? It seems clear that the blind man's attention is at the end of the stick – not in his hand, where the stick's vibrations are first 'felt' in the body. Our 'minds' do not stop at the edge of our skull, rather our whole 'structure' is embedded and enmeshed within countless arcs and patterns of interaction extending into the world. Learning is indicated by a shift in these patterns of interaction, by seeing differently, and therefore making new distinctions, in a particular context. In this report we look at varying professional learning activities through the lens of enactivism in order to consider the possible conditions of their effectiveness.

LOOKING AT PROFESSIONAL LEARNING ACTIVITIES

As we are adopting an enactivist lens our unit of analysis is activity and effective behaviour. In particular, we are interested in looking closely at what teachers can be paying attention to within professional development activity, what distinctions are

available to be made for these teachers, and how these distinctions could map onto the distinctions that are necessary in a classroom. The set of professional learning activities we have chosen to examine, then, is neither exhaustive nor hierarchical. Rather, they are teacher-learning activities that afford us varying distinctions between what happens during the activity and what might happen in the classroom of the teacher. All three authors have been involved extensively in offering professional development to teachers of mathematics over one or more decades. We came to write this paper, partly through comparing our approaches to PD, and we draw on our experiences to consider the following range of activities: attending a lecture or course; watching a video recording of another teacher, or yourself; seeing someone else teach your class; being given an activity to try out in your classroom; being given a structure and an activity to try out in your classroom; being given a structure for activities to try out in your classroom (action research). In the next section, we consider each scenario, focusing on the questions from the Introduction.

PROFESSIONAL LEARNING ACTIVITIES

We consider each activity in turn, starting with a fictionalised example of what a teacher did, and then considering the ‘doings’ and distinctions that are in play.

Attending a lecture

Maha attends a lecture during a conference in which she is told about teaching methods in East Asian countries. The lecturer discusses the use of ‘variation’ in teaching and learning new concepts. The intention is that Maha adopts new ways of working in her classroom as a result of being in the lecture.

Maha is listening and attending to the distinctions and words of the speaker. Of course it is impossible we ever share the same meaning for words that categorise complex and multi-faceted elements of practice and observation (e.g., ‘variation’). Maha may recognise differences compared to her own practice, in what is being presented in the lecture. On one level, Maha cannot *not* change, however minimally, as a result of being in the lecture. But if she is to make new choices in her practice, after attending the lecture, she will need to recognise when there is an appropriate opportunity for making the distinctions offered. She will need to work to recognise in her own practice what is being discussed within the practice of someone else and perhaps work to ‘suspend’ (Varela and Scharmer, 2000) patterns of typical responses.

Watching a video recording of another teacher, or yourself

Pippa attends a ‘video club’ for teachers of mathematics, which involves watching video recordings of others teaching and showing others video recordings from her own classroom. The intention is that teachers will focus on using activities that promote student reasoning and learn about effective teaching strategies for promoting reasoning.

There is significant interest at this time in the use of video in the context of teacher learning (e.g., to mention just a tiny sample: Sherin, 2007; Star and Strickland 2008; Sherin and van Es 2009; Coles 2013). Typically, in a context of watching a video as part of a professional development course, there will be a facilitator who may guide or

steer discussion. Teachers may be invited to share what they see in the video, in relation (or not) to a particular focus such as ‘mathematical reasoning’. Pippa is, therefore, given an opportunity to share distinctions she observes in the video, which may be distinctions between actions she sees done by the teacher on the video and her own expectations or routines. These distinctions, perhaps clashes of expectations, are reported in many instances to lead to judgmental responses from teachers (Jaworski, 1990). It is reported that when discussion begins in a judgmental manner, it is hard for talk to be productive (Jaworski, 1990; Coles, 2013).

In both watching a video and being in a classroom, a teacher can notice students’ actions and become aware of what they might do in that context, or (in a classroom) simply act. The video potentially allows the bringing into awareness of habitual ways of responding in one’s classroom and, potentially, the awareness of alternatives.

Pippa may be involved in observing and evaluating other teachers as part of her job. In this case, there is a direct mapping from what is done in the video club to her evaluation role with other staff, i.e., in both cases she needs to observe another teacher and consider what to say about what she notices. If she is forced to observe in particular ways in the video club (e.g., following Jaworski (1990) and Coles (2013), she might have to start by just focusing on the detail of events and not any emotional judgments) there is the potential of her using a new way of observing in her observation work in school.

Seeing someone else teach your class

[This example is based on a real experience involving two of the authors.] Alf was teaching mathematics in a school in London and had a high attaining grade 8 class (aged 12-13). Laurinda spent a day in his school and taught this grade 8 a lesson on algebra (on number sequences and algebraic rules), with Alf observing from the back. The topic was chosen by Alf and was what the class would have been doing had he taught them.

Dick Tahta taught one of Laurinda Brown’s classes (in the 1970s) and Laurinda taught one of Alf Coles’ classes (in the 1990s) as described above; Alf has since taught lessons in other people’s classrooms, for example in the context of a primary school project (Coles and Scott, 2015).

We identify two sets of distinctions available from watching someone else teach your class. Firstly, there may be distinctions available around how the students in class behave differently to normal. Alf wrote, at the time of Laurinda taking his class (see Brown and Coles, 2008), of seeing his children ‘thinking mathematically’ and ‘being algebraic’ in a manner that he had never experienced before (in his own class or from observations of others). This set of distinctions is around seeing possibilities, in terms of what students can do and how they can be, that may never have even been around as things a teacher realised was possible.

The second set of distinctions mirrors ones available in some of the earlier activities, and these are around particular teaching decisions ‘I would not have done that’. In the

case of someone teaching your own class of students, there is a close fidelity to the situation in which you would be in the position of making those teaching decisions.

Being given an activity to try out in your classroom

Ben attends a professional development session on collaborative problem solving. During this session, the participants spend some time solving a mathematics problem posed by the facilitator of the session. The intention is that Ben will take this same problem and use it with his own class.

Unlike the watching of a video, where the activity is to observe others (or yourself) in the third person, solving a problem is a first-person activity. That is, teachers working individually or collaboratively to solve a mathematics problem are living the experience that is intended for students. Within this activity, the participants may become aware of the distinctions between the strategies that can be used to solve the problem and between the types of mathematics that can be used. If there is an opportunity to debrief this experience within the session then more of the same type of distinctions may be acquired. These distinctions need to be translated not only to a teacher's own classroom, but also from experiences as student to their role as teacher.

Being given a structure and an activity to try out in your classroom

Cathy attends a professional development session on collaborative problem solving. During this session, the participants are solving a mathematics problem in random groups working on wall-mounted whiteboards. After this the facilitator discusses his/her rationale for having them work in random groups and on whiteboards and the choice of task. After this they are given a new task to solve in new groups on whiteboards which is, again, debriefed. The participants are then told to try the same problem and the same structure within their own class.

As with being given an activity only, the work in the PD session is one of being a student, trying out the activities to be offered in the classroom. However, the difference is that, through being offered a structure and rationale for the activities, the teachers in the session are forced to split their attention and, simultaneously, to be in the action of working on some mathematics, and making distinctions about how their activity relates to its stated purpose. Mason (2002) discusses the layered awarenesses needed for engaging in activity while also noticing one's engagement in activity.

As with the activity of watching someone else teach your own students, enacting an activity within a set structure affords the teacher the opportunity of behaving differently. This can allow the teacher to see the students being mathematical in a way that they may not normally be. As such, a set of distinctions is available around seeing what is possible, not only by the students, but by the teacher's own hand.

Being given a structure for activities to try out in your classroom: action research

Nima attends a course, run at a University, that supports her to undertake action research in her own classroom. She chooses to focus on what she can do to make her students more resilient and independent. From her readings and course meetings, she decides to try out a range of new actions in her classroom and evaluates their success.

Nima's course sessions support the making of new distinctions in the classroom through provoking and encouraging new or different (from what had been done in the past) actions on the part of the teacher (Brown and Coles, 2011). In some sense, the learning of the teachers is not mediated by the course leader, in that no one else is observing what takes place in the classroom. The distinctions shared in course sessions are about individuals' classrooms. Structure is provided by the action research model (e.g., Altrichter et al., 2003), which provokes Nima into experimenting with novel classroom activities and noting the reaction.

VARIANTS AND INVARIANTS

Looking across the scenarios that have been sketched above, and the consideration of the distinctions made both within the session and in the classroom, it is clear that there are some things that remain the same and some things that are different, in the move into the classroom. We summarise these invariants and variants below.

PD activity	Invariant	Variant
Attending a lecture	Intention that teachers will make the same distinctions being made in the lecture	From listening <i>to</i> acting (incl. recognising a context for a new distinction)
Watching a video recording of another teacher, or yourself	The classroom context and observations of student (and teacher) activity are shared	From observing a classroom and responding to teachers <i>to</i> observing a classroom and responding to students
Seeing someone else teach your class	The classroom and the students stay the same	From observing <i>to</i> acting
Being given an activity to try out in your classroom	The activity itself stays the same	Moving from acting as a student <i>to</i> acting as a teacher
Being given a structure and an activity to try out in your classroom	The activity and structure stay the same	Moving from acting as a student and (in parallel) as an observer of those actions <i>to</i> acting as a teacher and observer of student actions
Being given a structure for activities to try out in your classroom: action research	The focus of discussion is on distinction made by the teachers in their own classroom	Teachers need to implement actions discussed in sessions or suggested from readings

DISCUSSION

In several PD scenarios there is a passive to active shift required, from session to classroom, of moving from listener to actor (attending a lecture), or from observer to teacher (watching a video; seeing someone else teach your class). In other words, the doing in the PD session is quite different to the doing in the classroom. In other scenarios the doing in a PD session mirrors the intended doing of students (being given an activity / being given an activity and a structure) and a different translation is required. One phenomena we recognise is the offer in a PD session of an open problem to solve, which as a teacher we explore and solve in a particular manner – and the subsequent temptation to constrain the activity for students in the classroom to the particular method of solution we adopted, rather than the more open offer that we had received. If discussion in a PD session is focused on the distinctions of teachers (being given a structure for activities: action research) then the translation from session to classroom is one of noticing distinctions *after* classroom events to noticing them in-the-moment and using that awareness in acting differently.

Teacher learning and teacher change, from an enactivist perspective, are linked to the development of new habits in the classroom. For a change to occur, the teacher must act in a novel way in a given kind of scenario. One significant variant-invariant occurs when a PD session involves or leads to activity in the classroom that results in students in the classroom acting in a novel manner. Of course, this may be the result of any form of PD. However, there are certain forms of activity where it is likely that changes in student response will occur. Seeing someone else teach your class, will inevitably result in an observation of novel student behaviour and, where that behaviour is valued, such an experience provides a strong motivation to work on developing one's teaching. Seeing what is possible here and now with one's students, can be powerful. Being given an activity to try out can similarly result in students acting in novel ways. If the activity is far outside students' expectations and usual routines, it maybe that the change is not perceived in a positive light. Being given an activity and a structure to try out, similarly can result in new student behaviours (for example, observing students working on wall-mounted white boards). Where the structure offered for the activities provides a rationale, that structure can provide a tool to allow a teacher to continue experimenting and exploring the possibilities of these new ways of organising the classroom.

CONCLUSION

If we accept the enactivist adage that doing is knowing, then the organisers of professional development need to pay attention to who is doing what, during a PD session and to the relationship between the doing now and the doing in the classroom. It is possible to approximate the classroom context in a PD activity in a range of ways, through: discussing it (attending a lecture); recording it (watching a video); being in it (seeing someone teach your class); making teachers the students (being given an activity and/or structure); and, by researching it (action research). Each approximation

keeps some elements the same and changes others. Through each PD scenario, significant shifts occur when a teacher re-sees their context as offering new possibilities for acting and being in the classroom. It is clear to us that we cannot simply ‘give’ other people the distinctions we make. What we ‘see’ in a classroom is a result of our entire history of interaction. It is only through teachers articulating the distinctions they make (de-briefing after: watching a video; watching someone teach; engaging in an activity) that, as a leader of PD, we can become sensitive to those distinctions. We recognise that differences compared to expectations (e.g., what another teacher does or other students behave) can be experienced as ‘wrong’. Effective behaviour, within PD, may necessitate a letting-go of evaluative judgments and a re-directing of attention towards alternative behaviours and ways of being.

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